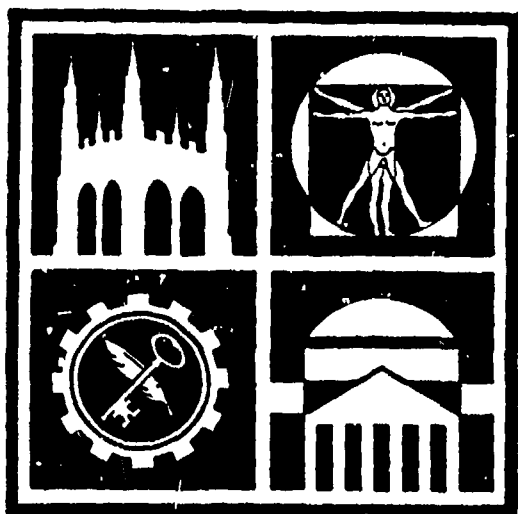


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A TECHNICAL REPORT PREPARED FOR THE NAVY RECRUITING COMMAND
AND THE OFFICE OF NAVAL CONTRACT UNDER
CONTRACT N00014-80-C-0200

THE TACTICAL ALLOCATION OF QUALITY RECRUITING
GOALS ACROSS REGIONS AND DISTRICTS: ITS USE
IN IDENTIFYING "EXCEPTIONAL" PRODUCERS

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March 15, 1982

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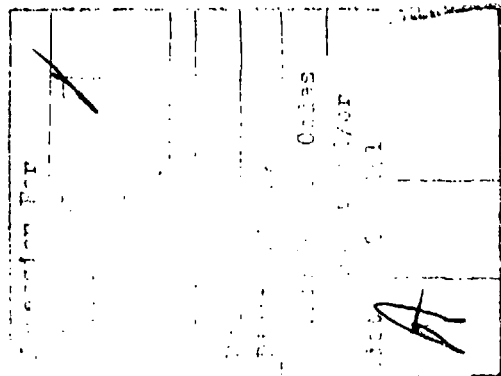
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1.0 BACKGROUND

1.1 Motivation and Focus

The Naval Recruiting Command is broken into six Regions, containing some forty-three recruiting districts. Each region is administered by a Regional Commander who receives from the Naval Recruiting Headquarters a quota for enlistments of various types, as well as an allotment of recruiting resources. One of his responsibilities is to then distribute these resources and quotas to the districts under his Command. Headquarters makes the decisions as to the allotment between the six Regions, and provides advice and consulting support to the Regional Commanders to aid them in their allocations.

The focus of this report is to explain, illustrate and document a computer program which can be run at the Naval Recruiting Command Headquarters. The program represents a sound and defensible tactical tool for aiding headquarters in equitably allocating the total national quota over the six Regions. It also provides suggestions to the Regional Commanders as to how they might allocate their assigned Regional quotas over the districts in their Regions. Finally, it can be helpful in identifying those "exceptional" districts and Regions, exceptional in the sense that they appear to do either significantly better or worse than the predicted performance for the area; this is after the area's performance has been adjusted to account for their individual levels of demographics and resources.



It should be emphasized that the method to be discussed should be viewed primarily as a short run, tactical decision aid; this is in contrast to longer range, strategic planning efforts. The short run, tactical problem faced each year by Headquarters, prior to the initiation of each new Fiscal Year, can be stated as follows:

i) Headquarters cannot in the short term drastically alter the mix of recruiters in the field; ii) headquarters does not have detailed knowledge of the upcoming advertising campaigns (at least as to the mix of media impacting each geographical area by month; iii) only approximate forecasts of any changes in an area's demographics (such as the local unemployment rate, the number of male high school seniors, the percent of the male, 17-21 year old population that is black, the percent of the male, 17-21 year old population that is included in a SMSA, etc.) are available for the upcoming year. Given these constraints, the first task is to allocate, at least on a percentage basis, the national, yearly enlistment quotas across the six Regions equitably. The second task is to provide guidance to the Regional Commanders as to how they might best perform their own internal allocations down to the district level.

One needs to appreciate that the above is a very different exercise than that associated with the longer term, strategic issue, of "How should recruiters, advertising expenditures, and goals be distributed over the country to maximize the cost-effectiveness of the resources?" The key difference is that in the latter strategic issue, one has the time to affect the many changes that may come out of the long

range planning analysis. This type of planning indeed has been the major thrust of this Principal Investigator's past efforts (see "A Multi-Year Budget Generation Program for Use in Navy Recruiting: A User's Manual" and "A Goal Setting Procedure for the Navy's Delayed Entry Program", Reports prepared under Contract N00014-30-C-0200 between the Office of Naval Research and Duke University, Richard C. Morey, October, 1981). These analyses, using sophisticated optimization approaches, all presume that Headquarters has the wherewithall to implement the recruiter and advertising mixes that come out of the analysis. However, in reality a substantial amount of lead time is necessary to be able to move recruiters around, change the mix and timing of advertising, etc.

Returning to the tactical, near-term problem, there is a critical need, both for morale and for cost-effectiveness reasons, to be able to spread the national quota across the six Regions in as fair a manner as possible. Regions which did very well the previous year (in terms of exceeding their given quotas) should not necessarily be penalized by arbitrarily raising their quotas this year. Rather those decisions need to be based on a scientific and objective assessment of what reasonably can be expected from each Region, given its forecasted demographics and the recruiter resources that are "locked in" to each Region. Only if it can be demonstrated that a given Region's excelling of its expected performance was the result of some new demographic or change in circumstance, would an increase in the Region's quota be justified.

With this as the underlying philosophy, this report (and the accompanying computer program) addresses this problem for the quality recruits, i.e. those with a High School Degree (including GED's). Only quotas for quality recruits are really amenable to the analysis to be discussed since only they are truly supply limited. The approach to be used is referred to as multi-variate regression. Since the non-High School recruits tend to be demand limited (i.e. there are more applicants than slots available) regression methods, based on a fitting of productions to the mix of recruiting resources utilized, is not applicable. Indeed their inclusion in the regression analysis can mask the relationships sought for.

1.2 The General Method of Attack

The basic idea is to forecast the average number of male, non-prior service, Regular Navy plus reservists, HSG, enlistment contracts, expected from each district for the upcoming year. Those numbers are based on estimates of the numbers of recruiters (or recruiter man-years) expected in each district for the upcoming year as well as the forecasted levels of key demographics such as the unemployment scenario and the numbers of male High School seniors estimated for each district. A host of other factors can be entered as well as dealing with anticipated advertising levels and other minor demographics (they are listed subsequently). However, to facilitate its use, if any factor is not entered explicitly, the Program defaults to the levels occurring in FY 80.

The forecaster used was built using monthly, district data from the time period January, 1976 - December 1978 and hence consisted of 36

months x 43 districts, or 1,548 cells. A pooled cross-sectional, time series model, using a powerful heteroscelastic regression package, was used. This technique, unlike that of ordinary least squares regression, allows and adjusts for unequal variances of the error terms and autocorrelations over time. A Koyck term was used to capture the lagged effects of advertising, of recruiter efforts, and of the unemployment rate. A non-linear model resulted which captured the strong diminishing return nature of recruiting resources, whereby each additional recruit costs marginally more to obtain since the pool of eligibles is shrinking. District dummies were purposefully excluded from the regressions performed so that differences in managerial efficiencies were not captured. Details of the predictor are described in the earlier referenced reports. It suffices at this point to stress that when the predictor was exercised on independent years, it yielded very close results (as compared with the actual level of HSG contracts). To be specific, for FY 79 a fit of within 4% occurred; the fit for FY 80 was even closer with an error of only 2.5% on a nationwide basis. Hence, the predictor has undergone very rigorous validation testing.

The idea then is to apply the contract enlistment forecaster to each Region (and the districts within each Region) for the upcoming year. In addition to providing Headquarters with an estimate of the total absolute numbers of quality contract likely to be obtained, one can compute the fair percentage of the quality recruits that should come from each Region. The same can be done for each district within each Region. Hence to illustrate, upon exercising the forecaster for

FY 80, 19.84% of the total national quota for HSG contracts appears to be the fair level for Area 100. (This follows since the forecaster yielded a total of 62,306 HSG contracts nationally and 12,362 for the sum of all the districts in Area 100; in other words $1984 = 12,362/62,306$. To instill more credibility in the predictor, we note that in FY 80, the actual national number of HSG contracts obtained was 63,929, and for Area 100, it was actually 12,799. Additionally, for FY 80, one can compare, at the district level, the actual performances with the predicted performance, to help isolate "exceptional" districts. Field audits could then be used at these places to identify any systems, procedures or processes that should be dropped or made more widespread.

2.0 THE HSG CONTRACT FORECASTER

The validated regression model utilized included the following fourteen factors: i) # of recruiter man-months expended in each district by month, ii) the individual levels of dollars of advertising expended in the district by month for:

- a) LAMS (classified ads);
- b) National TV/Radio (GEP-General);
- c) Magazines (GEP-General);
- d) Direct Mail;
- e) Minority Advertising;
- f) JADOR (Joint Armed Forces, General and Minority).

(All advertising expenditures were inflation adjusted.)

iii) Size of Male High School Senior Population in district; iv) Local General Unemployment Rate in district by month; v) Size of Labor Force in district by month; vi) Ratio of Military Pay (First year) to Civilian Pay in district by month; vii) Proportion of the male, 17-21 population in district that is black; viii) Proportion of the male, 17-21 population in district that is in a SMSA; this captures the urban/rural flavor of the district; ix) The district's propensity to enlist as measured by responses to a questionnaire, capturing such diverse factors as the extent of military tradition in the area, proximity to military bases, education and income, etc.).

The major determinants of quality production were:

i) Recruiter man-months with a long-term elasticity of .7292; that is to be interpreted that a 10% increase in recruiters in a district is likely to be accompanied by about a 7.29% increase in HSG contracts, if everything else remained unchanged; ii) The Number of Male High School Seniors at .2449; iii) The Local General Unemployment Rate at .1809; iv) "Propensity" at .6694; v) Ratio of Military Pay to Civilian Pay at .1679.

3.0 RESULTS FOR FY 80

3.1 Results at the Regional Level

Based on an exercising of the predictor for FY 80, with the actual levels of resources expended and the actual demographics occurring, the following results would have been obtained (see Table 1):

TABLE 1: ACTUAL VERSUS PREDICTED FOR FY 80

<u>Region</u>	<u># of Districts</u>	<u>Actual HSG Contracts for FY 80</u>	<u>Predicted (Percent of Total) HSG Contracts for FY 80 (Ignoring Differences in Managerial Efficiency)</u>	<u>Performance (Relative to Predicted)</u>
100	7	12,799	12,362 (19.84%)	3.54% better than predicted
300	8	11,053	12,385 (19.88%)	10.75% poorer than predicted
400	8	13,508	11,528 (18.50%)	17.18% better than predicted
500	7	8,499	8,393 (13.47%)	1.27% better than predicted
700	8	7,333	8,343 (13.39%)	12.11% poorer than predicted
800	5	10,737	9,294 (14.97%)	15.53% better than predicted
Country	43	63,929	62,306 (100%)	2.5% better than predicted

Hence, had the predictor been used for FY 80, with perfect foreknowledge of the actual demographics and resources expended, the percentages in the 4th column would have been the percentages for the HSG quotas for that year. We also observe that Regions 400 and 800 appeared to substantially outperform the averages, and that Regions 300 and 700 appeared to substantially underperform. Regions 100 and 500 appear to be about on target.

Some caveats are in order before proceeding. It is possible there is some key demographic or factor (such as the levels of other services' advertising and recruiter levels, or income or education level) in the district that was omitted in the analysis that could help explain the deviations. The experience of the recruiters in each

district and the previously assigned district quotas themselves could also be possible explanations. One other very possible explanation is that there are indeed very real differences in the operating efficiencies across Regions; this could be due to the differences in a Region's philosophies, practices and internal allocations of recruiters and goals to its districts. Since any differences in managerial efficiencies were purposely excluded from the predictors, deviations of the actuals from the predicted could well be due to that cause. If this is the case, then field surveys, to help identify best practices, may be in order.

3.2 Suggestions for Allocating Quality Quotas to Districts Within Regions for FY 80

This section offers guidelines to aid the insights of the Regional Commanders so as to possibly improve their internal allocations of their Region's quality quotas to the districts within their Region. It is based on applying the previously mentioned regression analysis to the actual resource and demographic data for FY 80 at the district level. As before, differences in managerial efficiencies, as would have been captured if a district dummy variable had been included in the regression analysis, were purposefully excluded so as not to penalize districts which outperformed the averages. The Region Commander may wish to adjust the contract percentages coming out of the predictor to reflect differences in each district's Delayed Entry Pool at the beginning of the year.

Region 100 (7 Districts)

(12,362 HSG contracts predicted in FY 80; actual was 12,799)

NRD	101	13.49%
	102	18.64%
	103	14.45%
	104	17.03%
	105	8.61%
	119	14.42%
	161	13.38%
Region	100	100%

Region 300 (8 districts)(12,385 HSG predicted in FY 80;
11,053 actual)

NRD	310	11.49%
	311	9.80%
	312	16.06%
	313	12.74%
	314	12.52%
	315	13.13%
	347	9.46%
	348	14.79%
Region	300	100%

Region 400 (8 districts)(11,528 HSG contracts predicted
versus 13,508 actual)

NRD	407	8.79%
	408	8.70%
	409	12.00%
	417	13.54%
	418	14.43%
	420	9.68%
	422	12.95%
	423	9.9%
Region	400	100%

Region 500 (7 districts)(8,393 HSG contract predicted in
FY 80; 8,499 actual)

NRD	521	21.87%
	524	14.98%
	527	11.23%
	528	14.33%
	529	11.29%
	541	15.88%
	559	10.43%
Region	500	100%

Region 700 (8 districts)(8,343 HSG contracts predicted in
FY 80 versus 7,333 actual)

NRD	725	15.25%
	730	12.85%
	731	14.57%
	732	13.60%
	733	13.23%
	734	8.92%
	735	8.39%
	746	13.19%
Region	700	100%

Region 800 (5 districts)

(9,295 HSG contracts predicted for FY 80 versus 10,737 actual)

NRD	836	25.82%
	837	14.41%
	838	30.04%
	839	14.15%
	840	15.57%
Region	800	100%

4.0 IDENTIFICATION OF "EXCEPTIONAL" DISTRICTS BASED ON PERFORMANCE LEVELS
IN FY 80

This Section is included to identify a total of about one-third of the districts (i.e. 14 districts out of the 43) which might be termed "exceptional", based on the differences in their level of production of male HSG contracts in FY 80, compared to the predicted. Of these 14, there are 8 which did substantially better than was predicted and 6 that

did substantially worse than was predicted. Again, this type of information can be helpful in identifying those locations where selected field audits would be fruitful in uncovering particularly helpful or harmful processes that are being used.

Consider first the 8 exceptional districts which were high performers.

Exceptionally High Producing Districts for FY 80 (of Male HSG Contracts)

<u>District #</u>	<u>Predicted</u>	<u>Actual</u>	<u>Percent By Which Actual Exceeded Predicted</u>
105	1,064	1,263	18.7%
409	1,383	2,017	45.8%
418	1,663	1,941	16.7%
420	1,115	1,552	39.2%
422	2,646	3,068	15.9%
527	942	1,202	27.6%
837	1,339	1,709	27.6%
840	1,447	1,929	33.3%

In the same spirit, there were 6 districts which had substantially lower levels of HSG contracts in FY 80 than would have been predicted by the model. These are:

Exceptionally Underproducing Districts for FY 80
(of Male, Non-Prior Service, Regular Navy Plus Reservists, HSG Contracts)

<u>District #</u>	<u>Predicted</u>	<u>Actual</u>	<u>Percent By Which Actual Varied from Predicted</u>
312	1,988	1,589	-20.1%
314	1,551	1,245	-19.7%
348	1,831	1,529	-16.5%
725	1,272	1,086	-14.6%
734	743	583	-21.5%
735	699	547	-21.7%

APPENDIX: A User's Manual with an Illustration

A.1 Overview

The types of data and formatting required are very similar to that delivered in the "Multi-year Budget Generation Program" of Duke Univ. of October, 1981. In the listing of the program which follows, the data is read from the unit number 6.

A.2 Description

The program first reads the data for all the months for the first district, then reads the data for all the months for the next district and so on for each until it finishes reading the data for all 43 districts. For each type of demographic or resource to be entered in a given run, it is necessary to enter fourteen months of data for each district.

The fourteen months consist of the last two months of the previous fiscal year, and the twelve months corresponding to the fiscal year under consideration. These additional 2 months are needed to adjust for the lagged effects. Hence, if the year in question was FY 83 (i.e. October 82-September 83), and the only demographic to be modified was the local unemployment rate, then one would first need to enter forecasts, for each of the 43 districts, of the expected unemployment rates for the months of August, and September, 1982 as well as the forecasts for the months of October, 1982-September, 1983. Unless all of the data for a given factor, i.e. for the entire 14 month period is entered, the Program will not run. However, if no data is entered for a given factor, say the unemployment rate, the Program will default to the levels existing for the period August, September 1979, and October, 1979-September, 1980 (i.e. FY 80). Hence, if no new data was entered at all, the Program would reproduce the predictions for FY 80. The example at the end of this section is presented to illustrate these ideas.

A.3 Formats

The variables are read in the following formats:

	<u>Variable Description</u>	<u>Format</u>	<u>Columns</u>
1.	National Recruiting Dist. No. (WRD).	I3	1-3
2.	Year (e.g. 1982)	I3	4-6
3.	Month (e.g. month 8's the August month)	I3	7-9
4.	Number of recruiters	F4.0	10-13
5.	Number of national leads	F4.0	14-17
6.	Number of High Sch. Graduate Contracts, if used in mode to identify exceptional districts	F4.0	18-21

Adv. Expenditure Dollars

	<u>Format</u>	<u>Columns</u>
7. Media type I (TV + Radio + Billboards)	F7.1	22-28
8. Media type II (magazines + newspapers + suppl.)	F7.1	29-35
9. Direct mail	F7.1	36-42
10. All minority media (enlisted)	F7.1	43-49
11. JADOR (GEP-General and Minority)	F7.1	50-56
12. LAMS (classified ads)	F7.1	57-63
13. Male High School Seniors	F7.1	64-70
14. Labor Force	F7.1	71-77
15. Propensity	F7.4	78-84
16. Percent black of male, 17-21 year old population	F7.4	85-91
17. Percent of male, 17-21 old population in a SMSA	F7.4	92-98
18. Ratio of military pay to civilian pay	F7.4	99-105
19. General unemployment rate	F7.4	106-112
20. CPI for year in question (relative to level in 1967) (this is only used if estimated advertising expenditures are to be used).	F5.3	113-117.

It is important to include the decimal point in the data set except for variables 1 through 6. If there is a missing data, the program stops after writing an appropriate message.

1.4 Example

Suppose the fiscal year under consideration was FY 83. Therefore, the twelve months under consideration are October 1982 - September 1983. In addition to these twelve months' dates, data for August and

September of 1982, are required. Thus for each NRD, any data assumed to change from the FY 80 levels, is required for 14 months. These cards for 14 months should be arranged in chronological order. Consider the first NRD, no. 101. The first card will correspond to August 82 and will have NRD = 101, year = 82, month = 8 and the values of the 17 variables in the format explained in section A.3. The second card will correspond to September 82 and thus will have NRD = 101, year 82, month = 9 and the data for 17 variables. The third card will correspond to October 82 (the first month of the fiscal year under consideration) and will have NRD = 101, year 82, month = 10 and 17 variables. This will continue till the 14th card for September 1983 for NRD = 101 is read.

Next card will correspond the next NRD no. 102. The following 14 cards are arranged in the same way. The pattern of arrangement of 14 cards within one NRD is illustrated in the text. The NRD's are in ascending order. These are 602 cards in the input file.

To illustrate, consider the data sets presented below. The first, labeled "Base Year Date", is the data, by month, by district for the 14 month period August, 1979 - September, 1980 and represents the actual situation for FY 80. To illustrate the first line, in district 101, for the month of August, 1979 (i.e. month 8, year 1979), there were 106 recruiters in the field in that district, 185 NOIC leads that month, 154 HSG, male contracts were actually obtained, there was \$8,816 of TV/Radio/Billboard advertising impacting that district that month, \$151 of magazine advertising, \$19 of direct mail advertising, \$215 of minority

[illegible]

NOV 1977 2 180

AREA=500

NRD	ESTIMATED HSG	XFOR THE AREA
521	1835.4483	0.218680
524	1256.9924	0.145761
527	942.4774	0.112289
528	1202.9191	0.143319
529	947.2499	0.112864
541	1332.6234	0.158772
559	875.5622	0.104317

TOTAL 8393.3227

6000000000

AREA=700

NXD	ESTIMATED HSG	%FOR THE AREA
725	1272.6502	0.152537
730	1072.1466	0.128505
731	1215.9975	0.145743
732	1134.4762	0.135976
733	1103.8204	0.132301
734	1743.8207	0.089153
735	699.8479	0.083882
740	1100.5060	0.131904

TOTAL 8343.2361

FORM 100-2-1-1

AREA=800

NRD	ESTIMATED MSG	% FOR THE AREA
836	2400.1095	0.258226
837	1339.5821	0.144125
838	2792.3584	0.300429
839	1315.0044	0.141480
840	1447.5457	0.155740

TOTAL 9290.6102

[illegible]

advertising, \$2,615 of JADOR Advertising, \$3,891 of LAMS advertising; also there were 43,451/male High School seniors in the district, the labor force was 2,363,600, the propensity index was .2216, the percent of the male, 17-21 year old population in the district that was black was 7.2003%; 83.8312% of the male, 17-21 old population in the district resulted in a SMSA, the ratio of first year military pay to civilian pay was .6895, and the local general unemployment rate was 4.73%. Finally the CPI index for August, 1979 (relative to the base year level of 1 in 1967) was 2.211.

Using the data in the base set (i.e. not entering any new data), the predictions presented in Section 3 for FY 80 would result since all of the data elements would default to the FY 80 levels. (See Appendix 2).

Consider a new hypothetical run, say for FY 83 assuming that only two key demographics are varied, namely the number of male, HS seniors in each district and the local unemployment rate. Suppose for concreteness that it is assumed the number of male, HS seniors in each district of the year in question is reduced to 92% of the levels in FY 80, but the local unemployment rates are all increased by two percentage points. Hence, e.g. for district 101 for the month of August of 82, (i.e. 2 months before the start of fiscal year 83), the male HS senior population is assumed to be only 39,975 (compared to 43,451 in August, 1979, i.e. $39,975 = .92(43,451)$) and the local unemployment rate has risen by two percentage points from 4.73% in August, 1979 to 6.73% in August, 1982. (This represents almost a 50% increase in the local unemployment rate.)

Hence since the elasticity on HSG contracts for the unemployment rate is about equal to the elasticity on HSG contracts for HS seniors, one would expect the large rise in the unemployment rate to more than offset the lower production due to the drop in HS seniors of 8%. The result should be an increase in the absolute levels of HSG contracts obtained. Indeed this is the case as can be seen from the run, the total number of HSG, male contracts now being estimated at 64,219 (in contrast to the 62,306 estimated for FY 80.) The new percentages for each region are also given and very slightly from those for FY 80.

RESULTS FOR HYPOTHETICAL ILLUSTRATION

<u>Regions</u>	<u>Number of Male HSG Contracts Predicted</u>	<u>Percentages</u>
100	12,701	19.78%
300	12,785	19.91%
400	11,812	18.39%
500	8,681	13.52%
700	8,677	13.51%
800	9,564	14.89%
Country	64,219	100%

[illegible]

APR 21 1960

AREA=100

NRD	ESTIMATED MSG	XFOR THE AREA
101	1667.1784	0.134868
102	2381.7706	0.156355
103	1745.8006	0.144400
104	3104.6757	0.170259
105	1064.2472	0.086126
106	1761.2303	0.144151
107	1653.5753	0.133767

TOTAL 12361.5742

APPROX 1/20

AREA=300

NO	ESTIMATED HRS	% OF THE AREA
310	1423.5785	0.114949
311	1214.1014	0.098031
312	1194.6575	0.160571
313	1574.9341	0.127747
314	1550.4831	0.125191
315	1625.8225	0.131274
316	1172.2131	0.094648
317	1831.6572	0.147898

TOTAL 12384.9438

APPENDIX 2 1 120

AREA=400

NPD	ESTIMATED MSG	FOR THE AREA
407	1013.7025	0.047920
408	1003.3022	0.087032
409	1383.3527	0.119094
417	1501.3812	0.135417
418	1603.1242	0.144262
420	1112.5602	0.096766
422	2640.0756	0.229523
423	1141.9338	0.060053

TOTAL 11528.4729

APPENDIX 2 V 181

AREA=500

NRD	ESTIMATED HSG	XFDR THE AREA
521	1835.4483	0.218680
524	1258.9724	0.119761
527	1942.4774	0.112389
528	1202.9191	0.114319
529	1947.2499	0.112314
541	1832.6234	0.112377
559	875.5622	0.104317

TOTAL 8393.3227

ADDITIONAL

AREA=700

ARC
725
730
731
732
733
734
735
740

ESTIMATED HSG WFOR THE AREA
1272.6502
1072.1866
1215.9075
1134.4762
1103.8304
1743.8307
699.8379
1100.5066

TOTAL

8343.2361

APPENDIX 2

AREA=800

NRD	ESTIMATED HSG	*FOR THE AREA
816	240.1095	0.258226
837	138.1521	0.144125
838	179.3524	0.300429
839	1315.0042	0.141280
840	1447.5457	0.155740

TOTAL 924.6102

APPENDIX 2

1980

AREA SUMMARY

100	12391.5762	0.198401
300	12394.0438	0.192776
400	11523.47329	0.145029
500	11523.47327	0.145029
700	11523.47327	0.145029
800	11523.47327	0.145029

TOTAL 62306.1638

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those who significantly underproduced or overproduced after the performances have been adjusted to account for differences in resources and demographics. It's illustrated using actual data for FY80.